# Climate control on the channel morphodynamics of the Sittaung River, Myanmar

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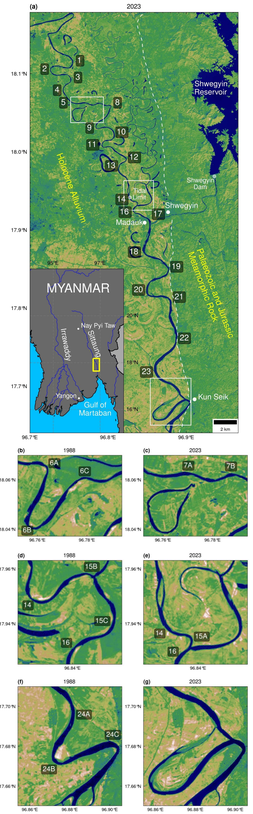
## Abstract

This study presents a satellite-based analysis of multi-decadal climatic forcing on the **migration rate** of the Sittaung River in Myanmar. The mode of ENSO exerts **significant** control on the migration rate of the meandering channels of the Sittaung River, with **low-to-average** migration rates observed during **dry El Niño events** and **peak** migration rates observed during **wet La Niña events**.

In cases where meanders faced **geological basement**, the basement rock inhibited their migration through extension, forcing more rapid migration by way of **seaward translation**. These translating meanders developed to be more **elongate**, with lower curvatures. Meanders downstream of the approximate tidal limit were less downstream skewed, indicative of **tidal modulation**, potentially obscuring the impact of fluvially driven climate forcing.

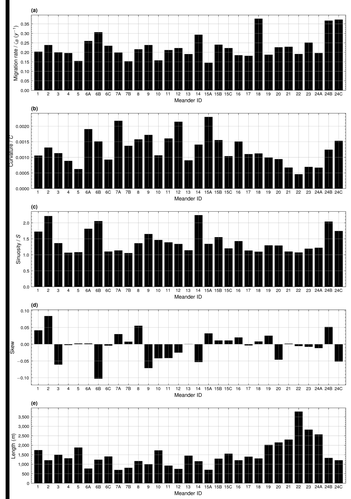
## Study Area

**Figure 1.** *Study area and meander cut-off locations*




## Results

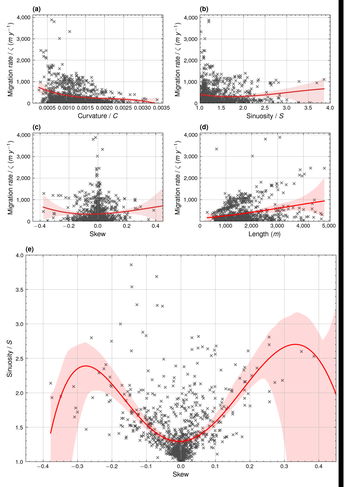
**Figure 2.** *Average downstream meander bend parameters for the period of 1988 to 2023*




**Peak migration rates** greater than 1500 ζ occurred only for meanders with **curvatures less than 0.0010**, while migration rates for meanders with curvatures greater than 0.0017 did not exceed 700 ζ (Fig. 3a).

Further, these cases of peak migration rate only occurred when sinuosity did not exceed 1.4 (Fig. 3b).

**Figure 3.** *Relationships between meander bend parameters*



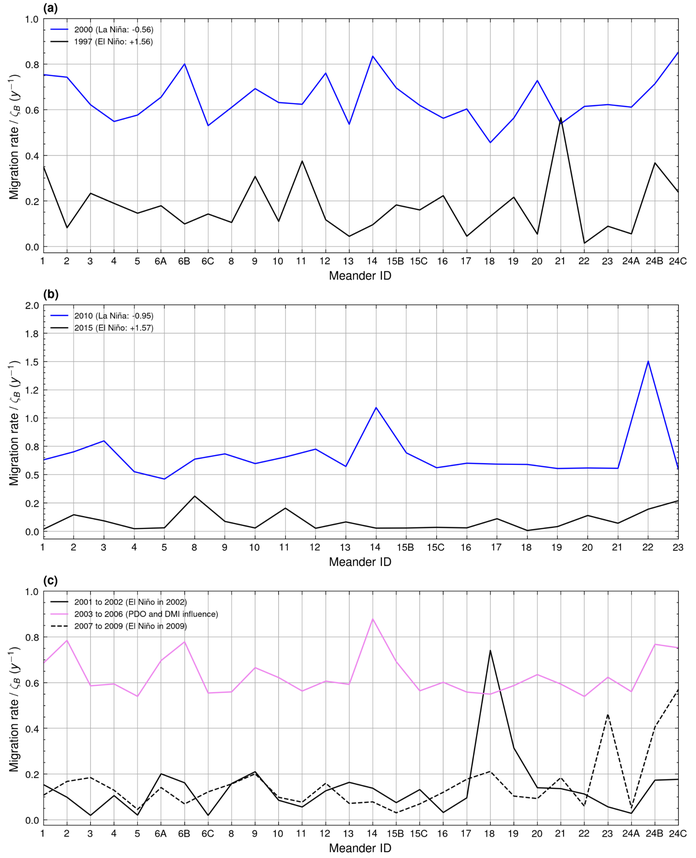

**Peak migration rate** at meanders 18, 24B, and 24C (Fig. 2a) lies directly **after the major confluence** present after meander 17 (Fig. 1a).

**Migration rate decreases with increasing curvature** (Fig. 3a).

## Discussion

### Climate control on meander migration rate

**Figure 4.** *Migration rate ($y^{-1}$) for meanders present during periods of El Niño, La Niña, and PDO and DMI (IOD) influence*

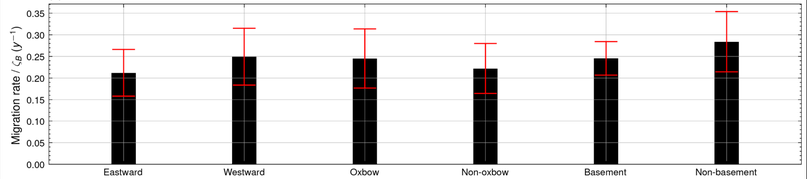



During La Niña years, the region of high precipitation within the Sittaung River drainage basin is extended further northwards than that during El Niño years, while high monthly mean precipitation is maintained throughout the monsoon period from June to October, compared to the single peak of precipitation in June exhibited during El Niño years. These factors are likely to have led to the **higher migration rate** during the **La Niña** years of 2000 (Fig. 4a) and 2010 (Fig. 4b). The forcing of the **positive PDO** and **negative DMI** is likely to have contributed to the **high rate of meander migration** during **weak ENSO** years (Fig. 4c).

### Factors obscuring climate forcing

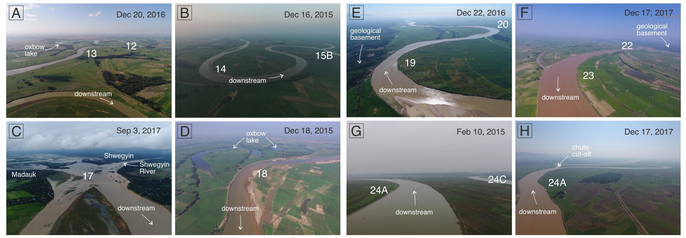
During peak meander migration years, **upstream** meanders recorded **higher** positive migration rate anomalies (mean + 0.430 $\zeta_B$) than **downstream** meanders (mean + 0.377 $\zeta_B$), while during dry El Niño conditions downstream meanders exhibited greater fluctuation in their annual migration rate compared to upstream meanders (Fig. 4). This suggests that **tidal modulation** may be masking the climate forcing of these downstream meanders' migration.

**Figure 5.** *Average meander bend migration for the period of 1988 to 2023 according to the environmental characteristics of the meander bends*




An **abandoned channel** and proximal **geological basement** may have impeded the extension of eastward facing meanders (Fig. 1a, Fig. 6e), resulting in their **lower** rate of migration (Fig. 5). Further, meanders facing a **geological basement** migrated faster than the overall mean of eastward facing meanders (Fig. 5), indicating the **inhibition of extension** and promotion of migration by way of more rapid **seaward translation**. Periods of storing or releasing water from the **Shwegyin Dam** (Fig. 1a) and **upstream mining activities** may have led to the **increased variability** in the migration rate for downstream meanders (Fig. 2a).

**Figure 6.** *Aerial photographs showing the meanders of the Sittaung River*




### Conclusions

In years of **El Niño** conditions, a **low-to-average rate of migration** is expected, while under strong **La Niña** conditions, the extended monsoon season can lead to **peaks of migration rate**. The extent of forcing exerted by ENSO is affected by the presence of proximal **geological basement** which can **inhibit** the **extension** of meander bends, forcing them to **migrate** primarily by **translation**. During periods of consistently **weak ENSO** forcing, the **PDO** and to a lesser extent the **IOD** may dictate the rate of fluvially driven meander migration. However, a downstream decrease in the sensitivity of climate forcing was identified, possibly indicative of **tidal modulation** and **anthropogenic influences**.